



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>5</sup> :</b> <b>A61K 9/22, 9/52, 31/58</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 91/07172</b> <b>(43) International Publication Date:</b> 30 May 1991 (30.05.91)
<b>(21) International Application Number:</b> PCT/SE90/00738 <b>(22) International Filing Date:</b> 15 November 1990 (15.11.90) <b>(30) Priority data:</b> 8903914-3 22 November 1989 (22.11.89) SE <b>(71) Applicant (for all designated States except US):</b> AKTIEBOLAGET DRACO [SE/SE]; Box 34, S-221 00 Lund (SE). <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only) :</b> ULMIUS, Jan [SE/SE]; Planvägen 6, S-222 47 Lund (SE). <b>(74) Agents:</b> MIKSCH, Gerhard et al.; AB Astra, Patent Department, S-151 85 Södertälje (SE).		<b>(81) Designated States:</b> AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CM (OAPI patent), DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GR, GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.  <b>Published</b> <i>With international search report.</i>
<b>(54) Title:</b> ORAL COMPOSITION FOR THE TREATMENT OF INFLAMMATORY BOWEL DISEASES  <b>(57) Abstract</b>  An oral pharmaceutical composition for use in the treatment of inflammatory bowel diseases and the use of certain glucocorticosteroids in the preparation of pharmaceutical compositions for the treatment by the oral route of ulcerative colitis and certain aspects of Crohn's disease.		

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FI	Finland	ML	Mali
AU	Australia	FR	France	MN	Mongolia
BB	Barbados	GA	Gabon	MR	Mauritania
BE	Belgium	GB	United Kingdom	MW	Malawi
BF	Burkina Faso	GN	Guinea	NL	Netherlands
BG	Bulgaria	GR	Greece	NO	Norway
BJ	Benin	HU	Hungary	PL	Poland
BR	Brazil	IT	Italy	RO	Romania
CA	Canada	JP	Japan	SD	Sudan
CF	Central African Republic	KP	Democratic People's Republic of Korea	SE	Sweden
CG	Congo	KR	Republic of Korea	SN	Senegal
CH	Switzerland	LI	Liechtenstein	SU	Soviet Union
CI	Côte d'Ivoire	LK	Sri Lanka	TD	Chad
CM	Cameroon	LU	Luxembourg	TC	Togo
DE	Germany	MC	Monaco	US	United States of America
DK	Denmark	MG	Madagascar		
ES	Spain				

5 ORAL COMPOSITION FOR THE TREATMENT OF INFLAMMATORY BOWEL  
DISEASES

Field of the Invention

10

The present invention relates to oral pharmaceutical compositions for use in the treatment of inflammatory bowel diseases and the use of certain glucocorticosteroids in the preparation of pharmaceutical compositions for the treatment by the oral route of certain inflammatory bowel diseases.

Background of the Invention

20 Inflammatory bowel disease is the term generally applied to two diseases, namely ulcerative colitis and Crohn's disease.

25 Ulcerative colitis is a chronic inflammatory disease of unknown aetiology afflicting only the large bowel and, except when very severe, limited to the bowel mucosa. The course of the disease may be continuous or relapsing, mild or severe. It is curable by total colectomy which may be needed for acute severe disease or chronic unremitting disease. Most patients with ulcerative colitis are managed medically rather than surgically.

35 Crohn's disease is also a chronic inflammatory disease of unknown aetiology but, unlike ulcerative colitis, it can affect any part of the bowel. Although lesions may start superficially, the inflammatory process extends through

- the bowel wall to the draining lymph nodes. As with ulcerative colitis, the course of the disease may be continuous or relapsing, mild or severe but, unlike ulcerative colitis it is not curable by resection of the
- 5 involved segment of bowel. Most patients with Crohn's disease come to surgery at some time, but subsequent relapse is common and continuous medical treatment is usual.
- 10 For treatment of acute attacks of ulcerative colitis, glucocorticosteroids such as prednisone or prednisolone acetate are almost invariably used and given by mouth for the average acute attack or relapse, or locally, by enema.
- 15 After remission has been achieved, sulphasalazine is the maintenance treatment of choice in treating ulcerative colitis. This drug, however, has a significant number of side effects chiefly due to absorption of the sulpha-pyridine moiety from the colon. Recently compounds which
- 20 contain only 5-aminosalicylic acid have been developed; these are as effective as sulphasalazine and do not have the sulphapyridine side effects but do have side effects of their own, notably diarrhoea.
- 25 Glucocorticosteroids are, however, not used for maintenance of remission in ulcerative colitis; doses that do not produce unacceptable side effects are ineffective, and patients who need chronic high dose glucocorticosteroids for control of their disease almost invariably
- 30 are treated by colectomy.

As with ulcerative colitis, glucocorticosteroids are the treatment of choice for severe active Crohn's disease, but ideally only to achieve remission, after which they

35 should be stopped. However, all too frequently the disease does not satisfactorily remit, and glucocorticosteroids may be necessary to maintain control of symptoms.

Sulphasalazine is also useful in less severe cases, particularly for disease involving the colon.

Very often in Crohn's disease, however, primary medical  
5 treatment of the disease process is ineffective, and only symptomatic treatment is of value i.e. analgesics for pain and opiates for diarrhoea. Most patients eventually require surgery.

#### 10 Disclosure of the Invention

Our studies indicate that the compositions according to the present invention may advantageously be used in the treatment of ulcerative colitis including idiopathic  
15 proctitis and certain aspects of Crohn's disease by the oral route.

In ulcerative colitis the compositions can be used for the treatment of both active and chronic continuous disease  
20 and as relapse preventing treatment (i.e. maintenance therapy once remission has been achieved).

In Crohn's disease the compositions can be used for the treatment of Crohn's colitis in its active phase and as  
25 relapse preventing therapy (i.e. maintenance therapy once remission has been achieved), and for the treatment of the small intestine as relapse preventing treatment (i.e. maintenance therapy).

30 It has been found that the diseases defined above can be treated using the anti-inflammatory steroids

(22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-11 $\beta$ ,21-dihydroxypregna-1,4-  
diene-3,20-dione [I],  
35 the 22R-epimer of [I],  
(22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-9 $\alpha$ -fluoro-11 $\beta$ ,21-dihydroxy-pregna-1,4-diene-3,20-dione [II],

- the 22R-epimer of [II],  
(22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ ,21-dihydroxy-pregna-1,4-diene-3,20-dione [III],  
the 22R-epimer of [III],  
5 (22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-11 $\beta$ -hydroxy-pregna-1,4-diene-3,20-dione [IA],  
the 22R-epimer of [IA],  
(22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-9 $\alpha$ -fluoro-11 $\beta$ -hydroxy-pregna-1,4-diene-3,20-dione [IIA],  
10 the 22R-epimer of [IIA],  
the 21-acetate of (22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ -hydroxy-fluoropregna-1,4-diene-3,20-dione [IIIA],  
the 22R-epimer of [IIIA],  
15 (22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-11 $\beta$ ,21-dihydroxypregn-4-ene-3,20-dione [IV],  
the 22R-epimer of [IV],  
(22RS)-16 $\alpha$ ,17 $\alpha$ -pentylidenedioxy-11 $\beta$ ,21-dihydroxypregn-4-ene-3,20-dione [V],  
20 the 22R-epimer of [V],  
(22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-11 $\beta$ ,21-dihydroxypregn-4-ene-3,20-dione [IVA],  
the 22R-epimer of [IVA],  
(22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -pentylidenedioxy-11 $\beta$ ,21-dihydroxypregn-4-ene-3,20-dione [VA],  
25 the 22R-epimer of [VA],  
methyl (20RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-11 $\beta$ -hydroxy-androsta-1,4-diene-3-one-17 $\beta$ -carboxylate [VI],  
the 20R-epimer of [VI],  
30 methyl (20RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-9 $\alpha$ -fluoro-11 $\beta$ -hydroxy-androsta-1,4-diene-3-one-17 $\beta$ -carboxylate [VII],  
the 20R-epimer of [VII],  
methyl (20RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ -hydroxy-androsta-1,4-diene-3-one-17 $\beta$ -carboxylate [VIII],  
35 the 22R-epimer of [VIII],  
methyl (22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ -hydroxy-3,20-dioxypregna-1,4-diene-21-oate [IX] and

the 22R-epimer of [IX].

Compound [I] has the approved name "budesonide".

- 5 Compound [I] and its 22R-epimer are particular preferred compounds.

Budesonide and compounds [II], [III], [IA], [IIA] and [IIIA] are described and claimed in Swedish Patent  
10 Specification 378 109. Budesonide is known to have an anti-inflammatory activity and, compared to prednisone, prednisolone and other glucocorticosteroids, an advantageous ratio between local and systemic effect when administered topically to the skin or to the lungs by  
15 inhalation.

Budesonide is a potent steroid, which is successfully used when locally treating (via aerosol) asthma and rhinitis. Also controlled trials of budesonide enema for locally  
20 treating proctitis and distal ulcerative colitis are in progress (Danielsson Å et al: A controlled randomized trial of budesonide versus prednisolone retention enemas in active distal ulcerative colitis, Scand. J. Gastroenterol. 22 :987-992, 1987 and Danielsson Å et al:  
25 Controlled trial of budesonide enema and placebo in proctitis and distal ulcerative colitis. Scand. J. Gastroenterol. 24. supplement 159:88). The use of oral budesonide in the treatment of small bowel Crohn's disease in its active phase has been described (Wolman SL: Use of  
30 oral budesonide in a patient with small bowel Crohn's disease and previous pseudotumor cerebri secondary to steroids. Scand. J. Gastroenterol. 24, Supplement 158:146-147).

35 The characteristic profile of budesonide when used for the treatment of these diseases is a high anti-inflammatory effect at the place of application but a low degree of

unwanted systemic glucocorticoid side effects. The low degree of systemic side effects of budesonide is a result of a high first pass liver metabolism transferring budesonide into substantially less active metabolites.

5

Especially the 22R-epimer of budesonide seems to be very promising in the treatment of inflammatory bowel diseases as hereinbefore defined when orally administered because, compared to budesonide it is more potent, is more rapidly  
10 metabolised by the liver and thus less available in the systemic circulation and thereby causing less unwanted systemic effects.

The 22R-epimers of compounds [I], [II], [III], [IA], [IIA]  
15 and [IIIA] are described and claimed in Swedish Patent Specification 378 110.

Compounds [IV], [V], [IVA], [VA] and the 22R-epimers thereof are described and claimed in European Patent  
20 Specification 54010.

Compounds [VI], [VII], [VIII] and the 20R-epimers thereof are described and claimed in European Patent Application  
25 143 764.

Compound [IX] and the 22R-epimer thereof are described and claimed in European Patent Application 232 690.

We have surprisingly found that the above identified  
30 glucocorticosteroids administered by the convenient oral route are of great potential benefit in the treatment of inflammatory bowel diseases as hereinbefore defined.

The above mentioned compounds thus potentially represents  
35 a very significant advance over other glucocorticosteroids which exert their effects systemically and other drugs previously used for the management of Crohn's disease,



particularly in avoiding the systemic side effects normally associated with glucocorticosteroid therapy. The high first pass liver metabolism of the drug renders possible its safe use in the maintenance therapy of the disease as well as achieving remission in the acute phase. Although Crohn's disease is not a very common condition, it is a chronic and often debilitating disorder that can benefit from a safer and more effective treatment.

10

In ulcerative colitis, the drug may help to reduce the number of patients having to undergo surgery and in addition, its lack of systemic effects makes it possible to use the drug for maintenance therapy once remission has been achieved.

15

The invention therefore provides pharmaceutical compositions comprising the glucocorticosteroids hereinbefore defined for use in the treatment by the oral route of bowel diseases as hereinbefore defined.

20

The invention also provides the use of the glucocorticosteroids as hereinbefore defined in the preparation of pharmaceutical compositions for the treatment by the oral route of bowel diseases as hereinbefore defined.

25

The invention further provides a method of treatment of bowel diseases as hereinbefore defined wherein an effective dose of a glucocorticosteroid as hereinbefore defined is administered by the oral route to a human or animal subject suffering from said bowel disease.

30

In order for the oral composition containing the glucocorticosteroids as hereinbefore defined to be applicable for the treatment of the bowel diseases as hereinbefore defined the composition must be adjusted to this particular purpose. The adjusted composition is a

35

further aspect of the present invention, and it can be used generally when treating ulcerative colitis and Crohn's disease.

5 The transit time through the gastro-intestinal canal for different dosage forms are rather well known. When the dosage form has been emptied from the stomach the transit through the small intestine takes 3 to 5 hours. The residence time in the large intestine is considerably  
10 longer, 25 to 50 hours. Ideally, as long as the dosage form remains in the stomach no release should occur. If Crohn's disease in small intestine is going to be treated the release should continue during about 5 hours after the dosage form has left the stomach. If the large  
15 intestine is going to be treated the release should ideally start at caecum, and continue for up to 50 hours.

The present invention utilizes pharmaceutical formulation techniques to provide compositions of a glucocortico-  
20 steroid for treating the inflammatory diseases of the bowel as hereinbefore defined. The glucocorticosteroid must have a chance to reach the inflamed part of the bowel in sufficient concentration and for a sufficient long time to exert its local action, in the case of Crohn's disease  
25 the whole bowel or only the small intestine and in the case of ulcerative colitis the caecum, colon and the rectum.

A multiple unit composition in a capsule has been found  
30 suitable for fulfilling the above-mentioned demands. In ulcerative colitis, the composition should be formulated so that the glucocorticosteroid is released preferentially during the passage of the colon. In Crohn's disease in the ileum the composition should be formulated  
35 so that the glucocorticosteroid is released preferentially during the passage of the small intestine. This can be accomplished by enteric and/or slow release

coating of the units containing the glucocorticosteroid. Such formulations of glucocorticosteroids are novel.

The dosage range for treatment of the bowel diseases as  
5 hereinbefore defined is suitably 2-20 mg divided into 1 to 4 doses during a 24-hour period.

#### Detailed description

10

The units will have a size between 0.3 and 5 mm, preferably a size between 0.5 and 2 mm. The units will be administered in hard gelatine capsules, the size of which will depend on the dose administered.

15

Each unit comprises a core, a first layer on the core and a second layer on the first layer.

The core consists of a non-pareil seed to which the  
20 glucocorticosteroid is applied or a seed in which the glucocorticosteroid is homogeneously distributed. The excipients used to prepare the seeds comprise one or more of pharmaceutically acceptable materials, e.g. sugar, starch, microcrystalline cellulose, waxes and polymeric  
25 binding agents.

The first layer on the non-pareil seeds comprises the glucocorticosteroid and a water-soluble or water-insoluble polymer which acts both as binder for the  
30 glucocorticosteroid and as a rate-limiting layer for release of the glucocorticosteroid. Such polymers may be selected from cellulose derivatives, acrylic polymers and copolymers, vinyl polymers and other high molecular polymer derivatives or synthetic polymers such as  
35 methylcellulose, hydroxypropylcellulose, hydroxypropylmethylcellulose, ethylcellulose, cellulose acetate, polyvinyl pyrrolidone, polyvidone acetate,

polyvinyl acetate, polymethacrylates and ethylene-vinyl acetate copolymer or a combination thereof. Preferred film-forming polymers are ethylcellulose or copolymers of acrylic and methacrylic acid esters (Eudragit NE, Eudragit 5 RL, Eudragit RS) in aqueous dispersion form.

The optionally first rate-limiting layer on the seeds with homogeneously distributed glucocorticosteroid comprises a water insoluble polymer or a mixture of water insoluble 10 polymers or a mixture of water soluble and water insoluble polymers mentioned above.

The polymers in the second layer may be selected from the group of anionic carboxylic polymers suitable for pharmaceutical purposes and being difficultly soluble at a low pH 15 but being soluble at a higher pH, the pH limit for solubility being in the interval of pH 4 to pH 7.5, said group comprising cellulose acetate phthalate, cellulose acetate trimellitate, hydroxypropylmethylcellulose 20 phthalate, polyvinyl acetate phthalate and acrylic acid polymers e.g. partly esterified methacrylic acid polymers such as Eudragit L, Eudragit L100-55 and Eudragit S. These polymers may be used alone or in combination with each other or in combination with water insoluble polymers 25 mentioned before. Preferred polymers are the Eudragits in aqueous dispersion form. The anionic carboxylic polymer comprises 25 to 100 % of the total polymer content.

The coatings may optionally comprise other pharmaceutically acceptable materials which improve the properties of 30 the film-forming polymers such as plasticizers, anti-adhesives, surfactants, and diffusion-accelerating or diffusion-retarding substances.

35 Suitable plasticizers comprise phthalic acid esters, triacetin, dibutylsebacate, monoglycerides, citric acid esters and polyethyleneglycols. Preferred plasticizers are

acetyltributyl citrate and triethyl citrate.

Suitable antiadhesives comprise talc and metal stearates.

- 5 The amount of the first coating applied on the units is normally in the range between 0.5% and 30% by weight, preferably between 1% and 15%. This amount includes in the relevant case the weight of the steroid as well. The amount of the second coating applied on the units is
- 10 normally in the range between 1% and 50% by weight, preferably between 2% and 25%, calculated on the weight of the coated units. The remainder constitutes the weight of the seed.
- 15 The preparation of the controlled release pellet formulation according to the present invention is characterized in that a non-pareil seed is enclosed in a layer of a glucocorticosteroid as hereinbefore defined and a water soluble or water insoluble polymer or a seed with
- 20 homogeneously distributed glucocorticosteroid as hereinbefore defined is optionally enclosed in a layer of a water insoluble polymer or a mixture of water insoluble polymers or a mixture of water soluble or water insoluble polymers which in turn is enclosed in a membrane of a
- 25 film-forming anionic carboxylic polymer or a mixture of a film-forming anionic carboxylic polymer and a water insoluble polymer which permits release of the glucocorticosteroid as hereinbefore defined in a manner set out below.
- 30 The controlled release pellet formulation according to this invention is thus characterized in that the pellet comprises

- i) a core consisting of a non-pareil seed or a seed in which a glucocorticosteroid as defined below is homogeneously distributed and
- ii) in case of a core consisting of a non-pareil seed, a layer of
- 5 a) a glucocorticosteroid selected from the group consisting of (22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-11 $\beta$ ,21-dihydroxypregna-1,4-diene-3,20-dione [I],
- 10 the 22R-epimer of [I],  
(22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-9 $\alpha$ -fluoro-11 $\beta$ ,21-dihydroxy-pregna-1,4-diene-3,20-dione [II],  
the 22R-epimer of [II],
- 15 (22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ ,21-dihydroxy-pregna-1,4-diene-3,20-dione [III],  
the 22R-epimer of [III],  
(22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidene-
- 20 dioxy-11 $\beta$ -hydroxypregna-1,4-diene-3,20-dione [IA],  
the 22R-epimer of [IA],  
(22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidene-
- 25 dioxy-9 $\alpha$ -fluoro-11 $\beta$ -hydroxy-pregna-1,4-diene-3,20-dione [IIA],  
the 22R-epimer of [IIA],  
the 21-acetate of (22RS)-21-acetoxy-
- 30 16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ -hydroxy-fluoropregna-1,4-diene-3,20-dione [IIIA],  
the 22R-epimer of [IIIA],  
(22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-11 $\beta$ ,21-
- 35 dihydroxypregn-4-ene-3,20-dione [IV],  
the 22R-epimer of [IV],  
(22RS)-16 $\alpha$ ,17 $\alpha$ -pentylidenedioxy-11 $\beta$ ,21-
- dihydroxypregn-4-ene-3,20-dione [V],  
the 22R-epimer of [V],

(22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidene-  
dioxy-11 $\beta$ ,21-dihydroxypregn-4-ene-3,20-  
dione [IVA],  
the 22R-epimer of [IVA],  
5 (22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -pentylidene-  
dioxy-11 $\beta$ ,21-dihydroxypregn-4-ene-3,20-  
dione [VA],  
the 22R-epimer of [VA],  
methyl (20RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-  
10 11 $\beta$ -hydroxy-androsta-1,4-diene-3-one-  
17 $\beta$ -carboxylate [VI],  
the 20R-epimer of [VI],  
methyl (20RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-  
9 $\alpha$ -fluoro-11 $\beta$ -hydroxy-androsta-1,4-  
15 diene-3-one-17 $\beta$ -carboxylate [VII],  
the 20R-epimer of [VII],  
methyl (20RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-  
6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ -hydroxy-androsta-1,4-  
diene-3-one-17 $\beta$ -carboxylate [VIII],  
20 the 22R-epimer of [VIII],  
methyl (22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-  
6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ -hydroxy-3,20-dioxy-  
pregna-1,4-diene-21-oate [IX] and  
the 22R-epimer of [IX] and  
25 b) a pharmaceutical acceptable film forming  
water insoluble or water soluble  
polymer, or  
in case of a core consisting of a seed in which  
a glucocorticosteroid as defined above is  
30 homogeneously distributed, an optionally layer  
of a pharmaceutically acceptable film forming  
water insoluble polymer or a mixture of water  
insoluble polymers or a mixture of water  
soluble and water insoluble polymers and  
35

- iii) a membrane surrounding said core and layer and containing a pharmaceutically acceptable film-forming anionic carboxylic polymer being difficulty soluble at low pH but being soluble at a higher pH, either alone or in combination with a pharmaceutically acceptable film-forming water insoluble polymer,
- the thickness of said layer or said membrane and/or the ratio of said anionic carboxylic polymer to said insoluble polymer being effective to prevent release of said glucocorticosteroid from said pellet in gastric fluids, but to permit release of said glucocorticosteroid from said pellet in intestinal fluids at a rate allowing treatment of the part of the intestinal tract where the disease resides, i.e. at a rate corresponding to a release time of 1 to 50 hours, preferably 5 to 10 hours when treating the small intestine and 25 to 50 hours when treating the large intestine, said rate being measured in vitro as a dissolution rate of said unit in simulated gastric and intestinal fluids, when measured in a flow through cell at 8 mL/min and 37°C substantially corresponds to the following for units intended for treating the small intestine:
- a) not more than 10%, preferably not more than 5%, of the total glucocorticosteroid is released after two hours in simulated gastric fluid in said assembly,
  - b) from 15 to 55%, preferably from 20 to 50%, of the total glucocorticosteroid is released after two hours in simulated intestinal fluid in said assembly,
  - c) from 35 to 80%, preferably from 40 to 70%, of the total glucocorticosteroid is released after four hours in simulated intestinal fluid in said assembly,



- d) not less than 60, preferably 60 to 90%, of the total glucocorticosteroid is released after eight hours in simulated intestinal fluid in said assembly,
- 5 e) not less than 80% of the total glucocorticoid steroid is released after twelve hours in simulated intestinal fluid in said assembly,
- and for units intended for treating the large intestine:
- 10 a) not more than 10%, preferably not more than 5%, of the total glucocorticosteroid is released after two hours in simulated gastric fluid in said assembly,
- 15 b) from 5 to 30%, preferably from 10 to 30%, of the total glucocorticosteroid is released after four hours in simulated intestinal fluid in said assembly,
- 20 c) from 20 to 65%, preferably from 35 to 55%, of the total glucocorticosteroid is released after twelve hours in simulated intestinal fluid in said assembly,
- 25 d) from 40 to 95%, preferably from 55 to 85%, of the total glucocorticosteroid is released after twenty-four hours in simulated intestinal fluid in said assembly,
- e) not less than 70%, preferably not less than 80%, of the total glucocorticosteroid is released after forty-eight hours in simulated intestinal fluid in said assembly.

30

In one embodiment of the composition there is a layer which comprises budesonide or the 22R epimer thereof and a water soluble or water insoluble polymer beneath the membrane surrounding the pellet.

35

In another embodiment of the composition the polymeric material in which budesonide or its 22R epimer is embedded

is selected from polyvinylpyrrolidone and hydroxypropylmethylcellulose or alternatively from ethylcellulose, cellulose acetate and copolymers of acrylic and methacrylic acid esters.

5

In still another embodiment of the composition the layer which comprises budesonide or its 22R epimer and a water soluble or water insoluble polymer includes one or more additional components selected from plasticizers, anti-  
10 adhesives and surfactants.

### Working examples

The following pharmaceutical compositions can be used in  
15 the treatment of bowel diseases according to the invention.

#### Example 1

		<u>mg/capsule</u>
20	Budesonide micronized	1.0
	Sugar spheres	321
	Aquacoat ECD 30	6.6
	Acetyltributyl citrate	0.5
	Polysorbate 80	0.1
25	Eudragit L100-55	17.5
	Triethylcitrate	1.8
	Talc	8.8
	Antifoam MMS	0.01

30 Budesonide (32.2 g) was suspended in the Aquacoat ECD 30 dispersion (0.70 kg) with the aid of the Polysorbate 80 (0.42 g) together with acetyltributyl citrate (15.8 g). The mixture was sprayed on to sugar spheres (10.2 kg) in a fluid bed apparatus. The enteric coating consisting of the  
35 Eudragit L100-55 dispersion, ( Eudragit L100-55 (0.558 kg), triethylcitrate (55.8 g), talc (0.279 kg), Antifoam MMS (0.44 g) and Polysorbate 80 (2.79 g)) was then sprayed

on the spheres. The pellets were dried in the fluid bed apparatus, sieved and filled in hard gelatine capsules.

The finished pellets were then subjected to a dissolution test as follows:

Apparatus: Flow-through cells (Sotax Dissotest CE6, equipped with 12 mm cells) at a flow rate of 8 mL/min and at 37°C.

Medium: Simulated gastric fluid (SGF), pH 1.2 and simulated intestinal fluid (SIF), pH 7.5 according to USP without enzymes.

Method: For the dissolution test in simulated gastric fluid, 2.8 g of pellets, and for the test in simulated intestinal fluid, 1.4 g of pellets were placed in the cells and the test commenced. For specified time periods fractions were collected and analyzed for budesonide by a liquid chromatographic method. The percentage dissolution at each time point was calculated. The results are shown in Table 1.

Table 1

Dissolution of budesonide of Example 1

Medium	Percentage dissolution after				
	1 hour	2 hours	4 hours	8 hours	12 hours
SGF	1	2	3	-	-
SIF	34	53	75	92	97

## Example 2

		<u>mg/capsule</u>
5	Budesonide micronized	2.0
	Sugar spheres	292
	Aquacoat ECD 30	4.8
	Acetyltributyl citrate	0.4
	Polysorbate 80	0.01
10	Eudragit NE30D	17.5
	Eudragit S100	17.5
	Talc	17.5

Budesonide (3.5 g) was suspended in the Aquacoat ECD 30 dispersion (28.0 g) with the aid of the Polysorbate 80 (0.02 g) together with acetyltributyl citrate (0.63 g). The mixture was sprayed on to sugar spheres (510 g) in a fluid bed apparatus. The rate-limiting and enteric coating consisting of Eudragit S100 (30.0 g) and talc (30.0 g) suspended in the Eudragit NE30D dispersion (100 g) with the aid of Polysorbate 80 (0.3 g) was then sprayed on the spheres. The pellets were dried, sieved and filled in hard gelatine capsules.

The finished pellets were then subjected to a dissolution test as follows:

Apparatus: Flow-through cells (Sotax Dissotest CE6, equipped with 12 mm cells) at a flow rate of 8 mL/min and at 37°C.

Medium: Simulated gastric fluid (SGF), pH 1.2 and simulated intestinal fluid (SIF), pH 7.5 according to USP without enzymes.

Method: For the dissolution test in simulated gastric fluid and simulated intestinal fluid, 2.8 g of pellets were placed in the cells and the test commenced. For specified time periods fractions were collected and analyzed for budesonide by a liquid chromatographic

method. The percentage dissolution at each time point was calculated. The results are shown in Table 2.

## 5 Table 2

### Dissolution of budesonide of Example 2

10	Medium	Percentage dissolution after (hours)								
		1	2	4	8	12	18	24	36	48
	SGF	0	0	1	-	-	-	-	-	-
15	SIF	5	8	13	20	27	35	43	56	67

## 20 Example 3

		<u>mg/capsule</u>
	Budesonide micronized	2.0
	Sugar spheres	305
25	Aquacoat ECD 30	5.0
	Acetyltributyl citrate	0.4
	Polysorbate 80	0.14
	Eudragit NE30D	12.6
	Eudragit S100	12.6
30	Talc	12.6

Budesonide (6.69 g) was suspended in the Aquacoat ECD 30 dispersion (56.0 g) with the aid of the Polysorbate 80 (0.04 g) together with acetyltributyl citrate (1.26 g).

35 The mixture was sprayed on to sugar spheres (1020 g) in a fluid bed apparatus. The rate-limiting and enteric coating consisting of Eudragit S100 (42.0 g) and talc (42.0 g) suspended in the Eudragit NE30D dispersion (140 g) with the aid of Polysorbate 80 (0.42 g) was then sprayed on the  
40 spheres. The pellets were dried, sieved and filled in hard gelatine capsules.

The finished pellets were then subjected to a dissolution test as follows:

Apparatus: Flow-through cells (Sotax Dissotest CE6, equipped with 12 mm cells) at a flow rate of 8 mL/min and at 37°C.

Medium: Simulated gastric fluid (SGF), pH 1.2 and simulated intestinal fluid (SIF), pH 7.5 according to USP without enzymes.

Method: For the dissolution test in simulated gastric fluid, 2.8 g of pellets, and for the test in simulated intestinal fluid, 2.1 g of pellets were placed in the cells and the test were placed in the cells and the test commenced. For specified time periods fractions were collected and analyzed for budesonide by a liquid chromatographic method. The percentage dissolution at each time point was calculated. The results are shown in Table 3.

20

Table 3

Dissolution of budesonide of Example 3

25

Medium	Percentage dissolution after (hours)							
	1	2	4	8	12	18	24	48
SGF	0	1	1	-	-	-	-	-
SIF	6	10	17	27	35	46	55	80

35

**Example 4**

		<u>mg/capsule</u>
5	Budesonide micronized	0.5
	Sugar spheres	286
	Aquacoat ECD 30	24.2
	Acetyltributyl citrate	1.8
	Eudragit NE30D	12.6
10	Eudragit S100	12.6
	Talc	12.6

Budesonide (0.90 g) was suspended in the Aquacoat ECD 30 dispersion (144 g) together with acetyltributyl citrate (1.82 g). The mixture was sprayed on to sugar spheres (510 g) in a fluid bed apparatus. The rate-limiting and enteric coating consisting of Eudragit S100 (22.5 g) and talc (22.5 g) suspended in the Eudragit NE30D dispersion (75.0 g) was then sprayed on the spheres. The pellets were dried, sieved and filled in hard gelatine capsules.

The finished pellets were then subjected to a dissolution test as follows:

Apparatus: Flow-through cells (Sotax Dissotest CE6, equipped with 12 mm cells) at a flow rate of 8 mL/min and at 37°C.

Medium: Simulated gastric fluid (SGF), pH 1.2 and simulated intestinal fluid (SIF), pH 7.5 according to USP without enzymes.

Method: For the dissolution test in simulated gastric fluid, 2.8 g of pellets, and for the test in simulated intestinal fluid, 2.1 g of pellets were placed in the cells and the test were placed in the cells and the test commenced. For specified time periods fractions were collected and analyzed for budesonide by a liquid

chromatographic method. The percentage dissolution at each time point was calculated. The results are shown in Table 4.

5 Table 4

Dissolution of budesonide of Example 4

10	Medium	Percentage dissolution after (hours)					
		1	2	4	8	12	18
	SGF	1	1	3	-	-	-
15	SIF	7	15	29	50	67	84

20

Absorption data for the budesonide formulation prepared in Example 1

Each of two healthy volunteers took the formulation in Example 1 corresponding to 9 mg of budesonide. Blood samples were drawn at different time-points up to 48 hours after drug administration. Plasma samples were analysed for budesonide by a specific HPLC-RIA method. The absorption process was estimated by the numerical point to point deconvolution method on plasma concentration data. The absorption values were scaled to the same final level by dividing the values with the absorption value at the last time-point when absorption was considered complete. The values are presented in Table 1. The absolute bioavailability was 10.8% and 9.6% for the two subjects, respectively. For comparison, the absolute bioavailability of a fast releasing budesonide capsule is 10 to 15%, and the mean absorption time is less than 2 hours. Of the dose absorbed about 30% and 55% was absorbed in the time interval 2 - 12 hours in the two subjects, respectively. Absorption in this time interval probably



occurs during the passage of the formulation through ileum, caecum and proximal colon.

Table 1A

5

Absorption of budesonide of Example 1

10 Subj no.	Percentage absorption after (hours)						
	1	2	4	8	12	24	36
3	-	7	14	23	37	83	100
15 5	13	39	61	85	94	99	100

20 Absorption data for the budesonide formulation prepared in Example 2

Each of two healthy volunteers took the formulation in Example 2 corresponding to 20 mg of budesonide. Blood samples were drawn at different time-points up to 72 hours after drug administration. Plasma samples were analysed for budesonide by a specific HPLC-RIA method. The absorption process was estimated by the numerical point to point deconvolution method on plasma concentration data. The absorption values were scaled to the same final level by dividing the values with the absorption value at the last time-point when absorption was considered complete. The values are presented in Table 2. The absolute bioavailability was 3.1% and 2.3% for the two subjects, respectively. For comparison, the absolute bioavailability of a fast releasing budesonide capsule is 10 to 15%, and the mean absorption time is less than 2 hours. Of the dose absorbed about 68% and 67% was absorbed in the time interval 6 - 36 hours in the two subjects, respectively. Absorption in this time interval probably occurs during the passage of the formulation through caecum and colon-rectum.

Table 2AAbsorption of budesonide of Example 2

5											
	Subj	Percentage absorption after (hours)									
10	no.	2	4	6	8	12	24	36	48	60	72
	4	5	15	24	29	48	80	92	96	98	100
15	5	5	19	33	43	57	87	100			

20 Absorption data for the budesonide formulation prepared in  
Example 3

Each of two healthy volunteers took the formulation in Example 4 corresponding to 20 mg of budesonide. Blood samples were drawn at different time-points up to 72 hours after drug administration. Plasma samples were analysed for budesonide by a specific HPLC-RIA method. The absorption process was estimated by the numerical point to point deconvolution method on plasma concentration data. The absorption values were scaled to the same final level by dividing the values with the absorption value at the last time-point when absorption was considered complete. The values are presented in Table 4. The absolute bioavailability was 6.3% and 4.9% for the two subjects, respectively. For comparison, the absolute bioavailability of a fast releasing budesonide capsule is 10 to 15%, and the mean absorption time is less than 2 hours. Of the dose absorbed about 67% and 71% was absorbed in the time interval 6 - 36 hours in the two subjects, respectively. Absorption in this time interval probably occurs during the passage of the formulation through caecum and colon-rectum.

Table 3AAbsorption of budesonide of Example 3

Subj no.	Percentage absorption after (hours)									
	2	4	6	8	12	24	36	48	60	72
1	6	16	27	35	53	83	94	98	99	100
3	1	2	6	16	28	57	78	91	97	100

Absorption data for the budesonide formulation prepared in Example 4

Each of two healthy volunteers took the formulation in Example 5 corresponding to 20 mg of budesonide. Blood samples were drawn at different time-points up to 72 hours after drug administration. Plasma samples were analysed for budesonide by a specific HPLC-RIA method. The absorption process was estimated by the numerical point to point deconvolution method on plasma concentration data. The absorption values were scaled to the same final level by dividing the values with the absorption value at the last time-point when absorption was considered complete. The values are presented in Table 5. The absolute bioavailability was 16.2% and 3.4% for the two subjects, respectively. For comparison, the absolute bioavailability of a fast releasing budesonide capsule is 10 to 15%, and the mean absorption time is less than 2 hours. Of the dose absorbed about 71% and 44% was absorbed in the time interval 6 - 36 hours in the two subjects, respectively. Absorption in this time interval probably occurs during the passage of the formulation through caecum and colon-rectum.

Table 4AAbsorption of budesonide of Example 4

5

10	Subj	Percentage absorption after (hours)									
	no.	2	4	6	8	12	24	36	48	60	72
	1	3	16	24	36	56	86	94	98	99	100
15	2	8	33	51	62	72	89	95	97	99	100

CLAIMS

1. A controlled release pellet formulation for oral administration in the treatment of inflammatory bowel diseases characterized in that the pellet comprises
- 5           i) a core consisting of a non-pareil seed or a seed in which a glucocorticosteroid as defined in this claim is homogeneously distributed and
- ii) in case of a core consisting of a non-pareil seed, a layer of
- 10                   a) a glucocorticosteroid selected from the group consisting of (22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-11 $\beta$ ,21-dihydroxypregna-1,4-diene-3,20-dione [I],
- 15                   the 22R-epimer of [I],  
                  (22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-9 $\alpha$ -fluoro-11 $\beta$ ,21-dihydroxy-pregna-1,4-diene-3,20-dione [II],
- 20                   the 22R-epimer of [II],  
                  (22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ ,21-dihydroxy-pregna-1,4-diene-3,20-dione [III],
- 25                   the 22R-epimer of [III],  
                  (22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-11 $\beta$ -hydroxypregna-1,4-diene-3,20-dione [IA],
- 30                   the 22R-epimer of [IA],  
                  (22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-9 $\alpha$ -fluoro-11 $\beta$ -hydroxy-pregna-1,4-diene-3,20-dione [IIA],
- 35                   the 22R-epimer of [IIA],  
                  the 21-acetate of (22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ -hydroxy-fluoropregna-1,4-diene-3,20-dione [IIIA],
- the 22R-epimer of [IIIA],  
                  (22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-11 $\beta$ ,21-

- 5 dihydroxypregn-4-ene-3,20-dione [IV],  
the 22R-epimer of [IV],  
(22RS)-16 $\alpha$ ,17 $\alpha$ -pentylidenedioxy-  
11 $\beta$ ,21-dihydroxypregn-4-ene-3,20-dione  
[V],  
the 22R-epimer of [V],  
(22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidene-  
dioxy-11 $\beta$ ,21-dihydroxypregn-4-ene-  
3,20-dione [IVA],  
10 the 22R-epimer of [IVA],  
(22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -pentylidene-  
dioxy-11 $\beta$ ,21-dihydroxypregn-4-ene-  
3,20-dione [VA],  
the 22R-epimer of [VA],  
15 methyl (20RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-  
11 $\beta$ -hydroxy-androsta-1,4-diene-3-one-  
17 $\beta$ -carboxylate [VI],  
the 20R-epimer of [VI],  
methyl (20RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-  
20 9 $\alpha$ -fluoro-11 $\beta$ -hydroxy-androsta-1,4-  
diene-3-one-17 $\beta$ -carboxylate [VII],  
the 20R-epimer of [VII],  
methyl (20RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-  
6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ -hydroxy-androsta-  
25 1,4-diene-3-one-17 $\beta$ -carboxylate [VIII],  
the 22R-epimer of [VIII],  
methyl (22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-  
6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ -hydroxy-3,20-dioxy-  
pregna-1,4-diene-21-oate [IX] and  
30 the 22R-epimer of [IX] and  
b) a pharmaceutical acceptable film  
forming water insoluble or water  
soluble polymer  
or in case of a core consisting of a seed in  
35 which a glucocorticosteroid as defined in this  
claim is homogeneously distributed, an  
optionally layer of a pharmaceutically

acceptable film forming water insoluble polymer or a mixture of water insoluble polymers or a mixture of water soluble and water insoluble polymers, and

- 5           iii) a membrane surrounding said core and layer and containing a pharmaceutically acceptable film-forming anionic carboxylic polymer being difficulty soluble at low pH but being soluble at a higher pH, either alone or in combination  
10           with a pharmaceutically acceptable film-forming water insoluble polymer,

the thickness of said layer or said membrane and/or the ratio of said anionic carboxylic polymer to said insoluble polymer being effective to prevent release of said  
15 glucocorticosteroid from said pellet in gastric fluids, but to permit release of said glucocorticosteroid from said pellet in intestinal fluids at a rate allowing treatment of the part of the intestinal tract where the disease resides, i.e. at a rate corresponding to a release  
20 time in vivo of 1 to 50 hours, preferably 5 to 10 hours when treating the small intestine and 25 to 50 hours when treating the large intestine.

2. A controlled release pellet formulation for oral  
25 administration in the treatment of inflammatory bowel diseases characterized in that the pellet comprises

- i) a core consisting of a non-pareil seed or a seed in which a glucocorticosteroid as defined in this claim is homogeneously distributed and  
30           ii) in case of a core consisting of a non-pareil seed, a layer of  
          a) a glucocorticosteroid selected from the group consisting of (22R3)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-11 $\beta$ ,21-dihydroxypregna-  
35           1,4-diene-3,20-dione [I],  
          the 22R-epimer of [I],  
          (22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-9 $\alpha$ -

fluoro-11 $\beta$ ,21-dihydroxy-pregna-1,4-  
diene-3,20-dione [II],  
the 22R-epimer of [II],  
(22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-6 $\alpha$ ,9 $\alpha$ -  
5 difluoro-11 $\beta$ ,21-dihydroxy-pregna-1,4-  
diene-3,20-dione [III],  
the 22R-epimer of [III],  
(22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidene-  
dioxo-11 $\beta$ -hydroxypregna-1,4-diene-3,20-  
10 dione [IA],  
the 22R-epimer of [IA],  
(22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidene-  
dioxo-9 $\alpha$ -fluoro-11 $\beta$ -hydroxy-pregna-1,4-  
diene-3,20-dione [IIA],  
15 the 22R-epimer of [IIA],  
the 21-acetate of (22RS)-21-acetoxy-  
16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-6 $\alpha$ ,9 $\alpha$ -difluoro-  
11 $\beta$ -hydroxy-fluoropregna-1,4-diene-3,20-  
dione [IIIA],  
20 the 22R-epimer of [IIIA],  
(22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-11 $\beta$ ,21-  
dihydroxypregn-4-ene-3,20-dione [IV],  
the 22R-epimer of [IV],  
(22RS)-16 $\alpha$ ,17 $\alpha$ -pentylidenedioxy-11 $\beta$ ,21-  
25 dihydroxypregn-4-ene-3,20-dione [V],  
the 22R-epimer of [V],  
(22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidene-  
dioxo-11 $\beta$ ,21-dihydroxypregn-4-ene-3,20-  
dione [IVA],  
30 the 22R-epimer of [IVA],  
(22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -pentylidene-  
dioxo-11 $\beta$ ,21-dihydroxypregn-4-ene-3,20-  
dione [VA],  
the 22R-epimer of [VA],  
35 methyl (20RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-  
11 $\beta$ -hydroxy-androsta-1,4-diene-3-one-  
17 $\beta$ -carboxylate [VI],



- the 20R-epimer of [VI],  
methyl (20RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-  
9 $\alpha$ -fluoro-11 $\beta$ -hydroxy-androsta-1,4-  
diene-3-one-17 $\beta$ -carboxylate [VII],  
5 the 20R-epimer of [VII],  
methyl (20RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-  
6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ -hydroxy-androsta-1,4-  
diene-3-one-17 $\beta$ -carboxylate [VIII],  
the 22R-epimer of [VIII],  
10 methyl (22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-  
6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ -hydroxy-3,20-dioxy-  
pregna-1,4-diene-21-oate [IX] and  
the 22R-epimer of [IX] and  
15 b) a pharmaceutical acceptable film forming  
water insoluble or water soluble polymer  
or  
in case of a core consisting of a seed in which  
a glucocorticosteroid as defined in this claim  
is homogeneously distributed, an optionally  
20 layer of a pharmaceutically acceptable film  
forming water insoluble polymer or a mixture of  
water insoluble polymers or a mixture of water  
soluble and water insoluble polymers, and  
iii) a membrane surrounding said core and layer and  
25 containing a pharmaceutically acceptable film-  
forming anionic carboxylic polymer being  
difficulty soluble at low pH but being soluble  
at a higher pH, either alone or in combination  
with a pharmaceutically acceptable film-forming  
30 water insoluble polymer,  
the thickness of said layer or said membrane and/or the  
ratio of said anionic carboxylic polymer to said insoluble  
polymer being effective to prevent release of said  
glucocorticosteroid from said pellet in gastric fluids,  
35 but to permit release of said glucocorticosteroid from  
said pellet in intestinal fluids at a rate allowing

treatment of the part of the intestinal tract where the disease resides, i.e. at a rate corresponding to a release time in vivo of 1 to 50 hours, preferably 5 to 10 hours when treating the small intestine and 25 to 50 hours when  
5 treating the large intestine, said rate being measured in vitro as a dissolution rate of said unit in simulated gastric and intestinal fluids, when measured in a flow through cell at 8 mL/min and 37°C substantially corresponds to the following for units intended for  
10 treating the small intestine:

- a) not more than 10%, preferably not more than 5%, of the total glucocorticosteroid is released after two hours in simulated gastric fluid in said assembly,
- 15 b) from 15 to 55%, preferably from 20 to 50%, of the total glucocorticosteroid is released after two hours in simulated intestinal fluid in said assembly,
- c) from 35 to 80 %, preferably from 40 to 70% of the  
20 total glucocorticosteroid is released after four hours in simulated intestinal fluid in said assembly,
- d) not less than 60, preferably 60 to 90%, of the total glucocorticosteroid is released after eight  
25 hours in simulated intestinal fluid in said assembly,
- e) not less than 80% of the total glucocorticoid steroid is released after twelve hours in simulated intestinal fluid in said assembly,

30

and for units intended for treating the large intestine:

- a) not more than 10%, preferably not more than 5%, of the total glucocorticosteroid is released after two hours in simulated gastric fluid in said  
35 assembly,
- b) from 5 to 30%, preferably from 10 to 30%, of the total glucocorticosteroid is released after four

hours in simulated intestinal fluid in said assembly,

5 c) from 20 to 65%, preferably from 35 to 55%, of the total glucocorticosteroid is released after twelve hours in simulated intestinal fluid in said assembly,

10 d) from 40 to 95%, preferably from 55 to 85%, of the total glucocorticosteroid is released after twenty-four hours in simulated intestinal fluid in said assembly,

e) not less than 70%, preferably not less than 80%, of the total glucocorticosteroid is released after forty-eight hours in simulated intestinal fluid in said assembly.

15

3. A formulation according to claim 1 or 2, characterized in that the said membrane is composed of an anionic carboxylic polymer and optionally a water insoluble polymer.

20

4. A formulation according to claim 3, characterized in that the anionic carboxylic polymer comprises 25 to 100% of the total polymer content.

25 5. A formulation according to claims 3 to 4 characterized in that the anionic carboxylic polymer is selected from cellulose acetate phthalate, cellulose acetate trimellitate, polyvinyl acetate phthalate, hydroxy-propylmethylecellulose phthalate and partly esterified  
30 methacrylic acid polymers.

6. A formulation according to claims 3 to 4 characterized in that the water insoluble polymer is selected from ethylcellulose, cellulose acetate, polyvinyl acetate,  
35 ethylene-vinyl acetate copolymer, and copolymers of acrylic and methacrylic acid esters.

7. A formulation according to claims 3 to 6 characterized in that the membrane includes one or more additional components selected from plasticizers, anti-adhesives and surfactants.
- 5 8. A formulation according to claims 3 to 7 characterized in that the membrane comprises between 1 and 50% and preferably between 2 and 25% of the total weight of the coated pellets.
- 10 9. A formulation according to claim 1 characterized in that the glucocorticosteroid is budesonide or the 22R epimer thereof.
- 15 10. A formulation according to claim 1 or 2 characterized in that beneath said membrane there is a layer which comprises budesonide or the 22R epimer thereof and a water soluble or water insoluble polymer.
- 20 11. A formulation according to claim 1 or 2 characterized in that beneath said membrane there is optionally a layer which comprises a water insoluble polymer or a mixture of water insoluble polymers or a mixture of water insoluble and water soluble polymers.
- 25 12. A formulation according to claim 10 characterized in that the polymeric material in which budesonide or the 22R epimer thereof is embedded is selected from polyvidone acetate, methylcellulose, hydroxypropyl cellulose, 30 polyvinylpyrrolidone and hydroxypropylmethylcellulose or alternatively from ethylcellulose, cellulose acetate, polyvinyl acetate, ethylene-vinylacetate copolymer, and copolymers of acrylic and methacrylic acid esters.
- 35 13. A formulation according to claim 11 characterized in that the polymeric material is selected from polyvidone acetate, methylcellulose, hydroxypropylcellulose,

polyvinylpyrrolidone and hydroxypropylmethylcellulose or alternatively from ethylcellulose, cellulose acetate, polyvinyl acetate, ethylenevinylacetate copolymer, and copolymers of acrylic and methacrylic acid esters.

5

14. A formulation according to claims 10 to 13 characterized in that the layer includes one or more additional components selected from plasticizers, anti-adhesives and surfactants.

10

15. A formulation according to claims 10 to 14 characterized in that the layer comprises between 0.5 and 30% and preferably between 1 and 15% of the total weight of the coated pellets.

15

16. A pellet formulation according to claim 1 or 2 characterized in that said core comprises budesonide or the 22R epimer thereof homogeneously distributed in pharmaceutically acceptable excipients or a non-pareil seed having a diameter preferably between 0.2 and 1.0 mm.

20

17. A process for the production of a pellet formulation according to any one of claims 1 to 16, which comprises making a core of pharmaceutically acceptable excipients with the glucocorticosteroid as defined in claim 1 homogeneously distributed therein and optionally enclosing this core with a water insoluble polymer or a mixture of water insoluble polymers or a mixture of water soluble and water insoluble polymers or of enclosing a core of a non-pareil seed in a layer of a glucocorticosteroid as defined in claim 1 and a water soluble or water insoluble polymer, and thereafter enclosing the thus coated core in a membrane of a film-forming anionic carboxylic polymer or a mixture of a film-formic anionic caboxylic polymer and a water insoluble polymer which permits release of the glucocorticosteroid in a manner set out in claim 1 or 2.

25

30

35

18. A capsule comprising a formulation of pellets according to any one of claims 1 to 16.

19. Use of a glucocorticosteroid selected from the group  
5 consisting of  
(22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-11 $\beta$ ,21-dihydroxypregna-1,4-  
diene-3,20-dione [I],  
the 22R-epimer of [I],  
(22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-9 $\alpha$ -fluoro-11 $\beta$ ,21-di-  
10 hydroxy-pregna-1,4-diene-3,20-dione [II],  
the 22R-epimer of [II],  
(22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ ,21-  
dihydroxy-pregna-1,4-diene-3,20-dione [III],  
the 22R-epimer of [III],  
15 (22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-11 $\beta$ -  
hydroxypregna-1,4-diene-3,20-dione [IA],  
the 22R-epimer of [IA],  
(22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-9 $\alpha$ -fluoro-11 $\beta$ -  
hydroxy-pregna-1,4-diene-3,20-dione [IIA],  
20 the 22R-epimer of [IIA],  
the 21-acetate of (22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidene-  
dioxy-6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ -hydroxy-fluoropregna-1,4-diene-  
3,20-dione [IIIA],  
the 22R-epimer of [IIIA],  
25 (22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-11 $\beta$ ,21-dihydroxypregn-4-  
ene-3,20-dione [IV],  
the 22R-epimer of [IV],  
(22RS)-16 $\alpha$ ,17 $\alpha$ -pentylidenedioxy-11 $\beta$ ,21-dihydroxypregn-4-  
ene-3,20-dione [V],  
30 the 22R-epimer of [V],  
(22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-11 $\beta$ ,21-  
dihydroxypregn-4-ene-3,20-dione [IVA],  
the 22R-epimer of [IVA],  
(22RS)-21-acetoxy-16 $\alpha$ ,17 $\alpha$ -pentylidenedioxy-11 $\beta$ ,21-  
35 dihydroxypregn-4-ene-3,20-dione [VA],  
the 22R-epimer of [VA],  
methyl (20RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-11 $\beta$ -hydroxy-

androsta-1,4-diene-3-one-17 $\beta$ -carboxylate [VI],  
the 20R-epimer of [VI],  
methyl (20RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-9 $\alpha$ -fluoro-11 $\beta$ -  
hydroxy-androsta-1,4-diene-3-one-17 $\beta$ -carboxylate [VII],  
5 the 20R-epimer of [VII],  
methyl (20RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ -  
hydroxy-androsta-1,4-diene-3-one-17 $\beta$ -carboxylate [VIII],  
the 22R-epimer of [VIII],  
methyl (22RS)-16 $\alpha$ ,17 $\alpha$ -butylidenedioxy-6 $\alpha$ ,9 $\alpha$ -difluoro-11 $\beta$ -  
10 hydroxy-3,20-dioxypregna-1,4-diene-21-oate [IX] and  
the 22R-epimer of [IX] in the preparation of a  
pharmaceutical composition for the treatment by the oral  
route of a bowel disease selected from the group  
consisting of ulcerative colitis, Crohn's colitis in its  
15 active phase, Crohn's colitis in its chronic phase as  
relapse preventing therapy and Crohn's disease in the  
small intestine as relapse preventing treatment.

20. Use of a glucocorticoid steroid as claimed in claim  
20 19 wherein the bowel disease is ulcerative colitis.

21. Use of a glucocorticosteroid as claimed in claim 19  
wherein the glucocorticosteroid is budesonide or the 22R  
epimer thereof.

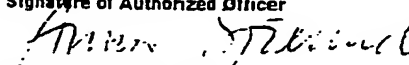
25

22. Use of a glucocorticosteroid as claimed in claim 19  
wherein the pharmaceutical composition is a controlled  
release pellet formulation for oral administration as  
defined in any of claims 1-18.

30

# INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 90/00738

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup> According to International Patent Classification (IPC) or to both National Classification and IPC <b>IPC5: A 61 K 9/22, 9/52, 31/58</b>		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
IPC5	A 61 K	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched <sup>8</sup>		
SE,DK,FI,NO classes as above		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>		
Category *	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
Y	Haematologia, Vol. 19, No. 41, 1986 A. Krasznai et al.: "Decreased Number of Steroid Receptors of Circulating Lymphocytes in Crohn's Disease and Ulcerative Colitis", see page 299 - page 301 see esp. p. 300, fig. 1, 1. 4 --	1-22
Y	EP, A2, 0278174 (GLAXO GROUP LIMITED) 17 August 1988, see esp. p. 3 --	1-22
X	Scandinavian journal of Gastroenterology Supplement, Vol. 24, No. 15, 1989 S.L. Wolman: "Use of Oral Budesonide in a Patient with Small Bowel Crohn's Disease and Previous Pseudotumor Cerebri Secondary to Steroids", see page 146 - page 147 see esp. 1. 16-17 --	19-22
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><sup>10</sup> Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p> </div> </div>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
12th February 1991	1991 -02- 18	
International Searching Authority	Signature of Authorized Officer	
SWEDISH PATENT OFFICE	 Anna Sjölund	



III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	WO, A1, 8300435 (J.B TILLOTT LIMITED) 17 February 1983, see the whole document --	1-18
A	Dialog Information Services, file 155, Medline, accession no. 05787468, Thomas P. et al: "Absorption of delayed-release prednisolone in ulcerative colitis and Crohn's disease", & J Pharm Pharmacol; 37 (10) p757-8 --	1-18
A	Scandinavian journal of Gastroenterology, Vol. 22, 1987 Å. Danielsson et al.: "A Contolled Randomized Trial of Budesonide versus Prednisolone Retention Enemas in Active Distal Ulcerative Colitis", see page 987 - page 992 --	19-22
A	STN International, file MEDLINE, STN accession no. 83226746, Gamstadt A. et al: "Effect of beta- methasone treatment on iodothyronines and thyroid hormone-binding proteins during controlled nutrition. A study on patients with chronic inflammatory bowel disease, Acta Endocrinol (Copenh), (1983 Jun) 103 (2) 188-91 -- -----	19-22

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 90/00738**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 90-12-28  
The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A2- 0278174	88-08-17	AU-D-	8296987	88-06-30
		GB-A-B-	2199747	88-07-20
		JP-A-	63233998	88-09-29
-----				
WO-A1- 8300435	83-02-17	AU-B-	551173	86-04-17
		AU-D-	8732482	83-02-22
		CA-A-	1172570	84-08-14
		EP-A-B-	0097651	84-01-11
		GB-A-B-	2123695	84-02-08